BEFORE THE
PUBLIC SERVICE COMMISSION OF
SOUTH CAROLINA

DOCKET NO. 2019-1-E

In the Matter of Annual Review of Base Rates for Fuel Costs for Duke Energy Progress, LLC	))))	**DIRECT TESTIMONY OF** **KELVIN HENDERSON FOR** **DUKE ENERGY PROGRESS, LLC**

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Kelvin Henderson and my business address is 526 South Church Street, Charlotte, North Carolina.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am Senior Vice President of Nuclear Operations for Duke Energy Corporation ("Duke Energy") with direct executive accountability for Duke Energy's North Carolina nuclear stations, including Duke Energy Progress, LLC's ("DEP" or the "Company") Brunswick Nuclear Station ("Brunswick") in Brunswick County, North Carolina, the Harris Nuclear Station ("Harris") in Wake County, North Carolina, and Duke Energy Carolinas, LLC's ("DEC") McGuire Nuclear Station, located in Mecklenburg County, North Carolina.

Q. WHAT ARE YOUR RESPONSIBILITIES AS SENIOR VICE PRESIDENT OF NUCLEAR OPERATIONS?

A. As Senior Vice President of Nuclear Operations, I am responsible for providing oversight for the safe and reliable operation of Duke Energy's nuclear stations in North Carolina. I am also involved in the operations of Duke Energy's other nuclear stations, including DEP's Robinson Nuclear Station ("Robinson") located in Darlington County, South Carolina.

Q. PLEASE SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE.

A. I have a Bachelor's degree in Mechanical Engineering from Bradley University and over 27 years of nuclear energy experience with increasing responsibilities. My nuclear career began at Commonwealth Edison's Zion Nuclear Station in Illinois

where I received a senior reactor operator license from the Nuclear Regulatory Commission ("NRC") and served as a control room unit supervisor. In 1998, I joined Progress Energy in the operations department at the Harris Nuclear Station. After serving in various leadership roles in Operations, Work Management, and Maintenance, I was named plant manager at Harris. In 2011, I was named general manager of nuclear fleet operations for Progress Energy. Following the Duke Progress merger in 2012, I became site vice president of DEC's Catawba Nuclear Station in York County, South Carolina. In 2016, I was named senior vice president of corporate nuclear, and I assumed my current role as Senior Vice President of Nuclear Operations in December 2017.

Q. HAVE YOU TESTIFIED BEFORE THIS COMMISSION IN ANY PRIOR PROCEEDINGS?

A. Yes, I testified in DEP's 2018 fuel costs proceeding in Docket No. 2018-1-E and in DEP's base rate proceeding in Docket No. 2018-318-E.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. The purpose of my testimony is to describe and discuss the performance of Brunswick, Harris, and Robinson for the period of March 1, 2018 through February 28, 2019 (the "review period").

Q. YOUR TESTIMONY INCLUDES THREE EXHIBITS. WERE THESE EXHIBITS PREPARED BY YOU OR AT YOUR DIRECTION AND UNDER YOUR SUPERVISION?

A. Yes. These exhibits were prepared at my direction and under my supervision.

Q. PLEASE PROVIDE A DESCRIPTION OF THE EXHIBITS.

A. The exhibits and descriptions are as follows:

Henderson Exhibit 1 - Calculation of the nuclear capacity factor for the review period pursuant to S.C. Code § 58-27-865

Henderson Exhibit 2 - Nuclear outage data for the review period

Henderson Exhibit 3 - Nuclear outage data through the billing period [1]

Q. PLEASE DESCRIBE DEP'S NUCLEAR GENERATION PORTFOLIO.

A. The Company's nuclear generation portfolio consists of approximately 3,575[2] megawatts ("MWs") of generating capacity, made up as follows:

Brunswick - 1,870 MWs

Harris - 964 MWs

Robinson - 741 MWs

Q. PLEASE PROVIDE A GENERAL DESCRIPTION OF DEP'S NUCLEAR GENERATION ASSETS.

A. The Company's nuclear fleet consists of three generating stations and a total of four units. Brunswick is a boiling water reactor facility with two units and was the first nuclear plant built in North Carolina. Unit 2 began commercial operation in 1975, followed by Unit 1 in 1977. The operating licenses for Brunswick were renewed in 2006 by the NRC, extending operations up to 2036 and 2034 for Units 1 and 2, respectively. Harris is a single unit pressurized water reactor that began commercial operation in 1987. The NRC issued a renewed license for Harris in 2008, extending operation up to 2046. Robinson is also a single unit pressurized water reactor that

[1] This data is provided in confidential and publicly redacted versions for security purposes.
[2] As of January 1, 2019

began commercial operation in 1971. The license renewal for Robinson Unit 2 was issued by the NRC in 2004, extending operation up to 2030.

Q. WERE THERE ANY CAPACITY CHANGES WITHIN DEP'S NUCLEAR PORTFOLIO DURING THE REVIEW PERIOD?

A. Yes. Efficiency gains from the replacement of the Harris low pressure turbine in the spring of 2018 increased the capacity of the unit. After seasonal observations and validation testing, the Harris maximum dependable capacity ("MDC") was increased by 32 MWs to 964 MWs effective January 1, 2019. The winter capability rating was also increased, adding 29 MWs to the unit's winter capability.

Q. WHAT ARE DEP'S OBJECTIVES IN THE OPERATION OF ITS NUCLEAR GENERATION ASSETS?

A. The primary objective of DEP's nuclear generation department is to safely provide reliable and cost-effective electricity to DEP's Carolinas customers. The Company achieves this objective by focusing on a number of key areas. Operations personnel and other station employees are well-trained and execute their responsibilities to the highest standards in accordance with detailed procedures. The Company maintains station equipment and systems reliably, and ensures timely implementation of work plans and projects that enhance the performance of systems, equipment, and personnel. Station refueling and maintenance outages are conducted through the execution of well-planned, well-executed, and high quality work activities, which effectively ready the plant for operation until the next planned outage.

Q. PLEASE DISCUSS THE PERFORMANCE OF DEP'S NUCLEAR FLEET DURING THE REVIEW PERIOD.

A. The Company operated its nuclear stations in a reasonable and prudent manner during the review period, providing approximately 46% of the total power generated by DEP. The four nuclear units operated at an actual system average capacity factor of 89.45% during the review period, which included three refueling outages. Output from three of the four DEP nuclear units was significantly impacted during the review period by Hurricane Florence. Prior to the expected landfall of Hurricane Florence, both Brunswick units were brought offline, consistent with site procedures. Brunswick Unit 1 was offline for 8.8 days and Unit 2 was offline for 6.3 days. After the Federal Emergency Management Agency ensured emergency preparedness capability had been restored in the region, both Brunswick units to returned to service. Additionally, the availability of Robinson was impacted by Hurricane Florence. As described later in my testimony, the Robinson refueling outage, which began one week after the hurricane's landfall, was impacted by resource constraints directly attributable to the hurricane and its aftermath.

As shown on Henderson Exhibit 1, DEP achieved a net nuclear capacity factor, excluding reasonable outage time, of 102.28% for the review period. This capacity factor is above the 92.5% set forth in S.C. Code § 58-27-865(F), which states in pertinent part:

> There shall be a rebuttable presumption that an electrical utility made every reasonable effort to minimize cost associated with the operation of its nuclear generation facility or system, as applicable, if the utility achieved a net capacity factor of ninety-two and one-half percent or higher during the period under review. The calculation of the net capacity factor shall exclude reasonable outage time associated with reasonable refueling, reasonable maintenance, reasonable repair, and reasonable equipment replacement outages; the reasonable reduced power generation experienced by nuclear units as they approach a refueling outage; the reasonable reduced

power generation experienced by nuclear units associated with bringing a unit back to full power after an outage....

The performance results discussed above support DEP's continued commitment for achieving high performance without compromising safety and reliability.

Q. WHAT IMPACTS A UNIT'S AVAILABILITY AND WHAT IS DEP'S PHILOSOPHY FOR SCHEDULING REFUELING AND MAINTENANCE OUTAGES?

A. In general, refueling requirements, maintenance requirements, prudent maintenance practices, and NRC operating requirements impact the availability of DEP's nuclear system. Prior to a planned outage, DEP develops a detailed schedule for the outage and for major tasks to be performed including sub-schedules for particular activities.

The Company's scheduling philosophy is to plan for a best possible outcome for each outage activity within the outage plan. For example, if the "best ever" time a particular outage task was performed is 10 days, then 10 days or less becomes the goal for that task in each subsequent outage. Those individual goals are incorporated into an overall outage schedule. The Company aggressively works to meet, and measures itself against, that schedule. Further, to minimize potential impacts to outage schedules, "discovery activities" (walk-downs, inspections, etc.) are scheduled at the earliest opportunities so that any maintenance or repairs identified through those activities can be promptly incorporated into the outage plan. Those discovery activities also have pre-planned contingency actions to ensure that, when incorporated into the schedule, the activities required for appropriate repair can be performed as efficiently as possible.

As noted, the Company uses the schedule for measuring outage planning and execution, and driving continuous improvement efforts. However, in order to provide reasonable, rather than best ever, total outage time for planning purposes, particularly with the dispatch and system operating center functions, DEP also develops an allocation of outage time which incorporates reasonable schedule losses. The development of each outage allocation is dependent on maintenance and repair activities included in the outage, as well as major projects to be implemented during the outage. Both schedule and allocation are set aggressively to drive continuous improvement in outage planning and execution.

Q. HOW DOES DEP HANDLE OUTAGE EXTENSIONS AND FORCED OUTAGES?

A. When an outage extension becomes necessary, DEP believes that work completed in the extension results in longer continuous run times and fewer forced outages, thereby reducing fuel costs in the long run. Therefore, if an unanticipated issue that has the potential to become an on-line reliability issue is discovered while a unit is off-line for a scheduled outage and repair cannot be completed within the planned work window, the outage is usually extended to perform necessary maintenance or repairs prior to returning the unit to service. In the event that a unit is forced off-line, every effort is made to safely perform the repair and return the unit to service as quickly as possible.

Q. DOES DEP PERFORM POST-OUTAGE CRITIQUES AND CAUSE ANALYSES FOR INTERNAL IMPROVEMENT EFFORTS?

A. Yes. The nuclear industry recognizes that constant focus on operational excellence results in improved nuclear safety and reliability. As such, DEP applies self-critical analysis to each outage to identify every potential cause of an outage delay or event resulting in a forced or extended outage. These critiques and cause analyses do not document the broader context of the outage or event, and thus rarely reflect strengths and successes.

Q. **WHAT IS THE RELATIONSHIP BETWEEN THE STANDARDS THAT THE COMPANY APPLIES IN ITS POST OUTAGE CRITIQUES AND THE "EVERY REASONABLE EFFORT" STANDARD OF SECTION 58-27-865?**

In the Company's outage evaluations, we are looking closely for any opportunity for improvement. We are not assessing the "reasonableness" of any conduct or actions that might have contributed to the outage. Reasonableness focuses on what was done in light of what was known prior to the event; in our outage evaluations we are focused on learning and applying new lessons from our experiences in order to improve our operations. The fact that an outage investigation may indicate ways we can improve our future operations does not indicate that we have determined that our previous practices did not meet the reasonableness standard.

Q. WHAT REFUELING OUTAGES WERE REQUIRED AT DEP'S NUCLEAR FACILITIES DURING THE REVIEW PERIOD?

A. There were three refueling outages completed during the review period: Brunswick Unit 1, Harris, and Robinson.

Brunswick Unit 1 was removed from the grid for refueling on March 3, 2018. In addition to refueling, safety, reliability, and regulatory enhancements and

projects were completed. Emergency Diesel Generator ("EDG") modifications were completed on EGD 2, including upgrades to starting air system, automatic voltage regulator, and governor. Completion of these safety and reliability enhancements on EDG 2 marks the completion of this safety and reliability enhancement project on all 4 of the station's EDGs. Regulatory work accomplished included the completion of all modifications associated with National Fire Protection Association Standard 805 ("NFPA 805") requirements and post-Fukushima required harden wetwell vent installation. Turbine-related work included the implementation of a digital turbine control system. The new system addresses equipment obsolescence and single-point vulnerabilities, enhancing the reliability of the station. A full turbine alignment and balance shot was also completed. After refueling, projects, maintenance, and inspections were completed, the unit returned to service on April 4, 2018. The outage was completed in 32.48 days compared to a 35-day allocation. Following the end of the refueling outage, the turbine was disconnected from the grid for just over 2 hours to complete overspeed testing.

The Harris spring refueling outage began on April 7, 2018. In addition to refueling activities, safety, regulatory, and reliability enhancements and projects were completed. Safety and regulatory work included reactor vessel head inspections and repair, and reactor vessel in-service inspections. Replacement of the station's low-pressure turbine addressed the aging of the existing turbine and mitigated the free-standing blade root cracking concerns. The new turbine also improved thermal efficiency and added 32 MWs to the station's capacity. After testing and validation during 2018, the station's maximum dependable capacity was

increased by 32 MWs to 964 MWs effective January 1, 2019. The station also completed installation of a new turbine control system. The new system addresses equipment obsolescence and single-point vulnerabilities, enhancing the reliability of the station. Other reliability work included refurbishment of the "B" reactor coolant pump motor and seals, "A" heater drain pump and motor, and overhaul of the auxiliary feed water turbine. All outage goals were met, and outage dose was the lowest ever recorded for a Harris refueling outage. After refueling, projects, maintenance, and inspection activity completed, the unit returned to service on May 10, 2018; a duration of 33.8 days compared to a schedule allocation of 37 days.

The Robinson refueling outage was originally scheduled to begin on September 15, 2018, just one day after Hurricane Florence made landfall along North Carolina's southeast coast. The outage start was delayed by one week, and on September 22, 2018, Robinson entered the fall refueling outage. In addition to refueling activities, significant safety, regulatory, and reliability enhancements were completed. Regulatory and safety enhancements included the transmission upgrade project ("TUP") and modifications required to transition to the NFPA 805. Significant activities associated with the TUP included replacement of the 115KV startup transformer, addition of a second 230KV startup transformer, and upgrades to the 4KV bus and transmission lines. The TUP provides the station with a second off-site power path, aligning the station with the current industry standard for U.S. nuclear plants. NFPA 805 modifications included replacement of refueling water storage tank discharge values, residual heat removal loop isolation valves, and loops "B" and "C" hotleg shutoff valves. Numerous new motor control centers and

distribution panels were also installed as part of the NFPA 805 modifications. A main power open phase detection modification was also completed. This system improves safety margins related to offsite power by providing a fully redundant open phase protection system.

Reliability enhancements included the replacement of both low-pressure turbines, which addressed blade design issues that have impacted generation since 2012. The Siemens low-pressure turbines were replaced under warranty. Other reliability enhancements included replacement of the "B" reactor coolant pump motor and seal replacements on "A', "B", and "C" pumps. The "B" heater drain pump was also replaced.

After refueling, maintenance, projects and inspection activities were completed, the unit returned to service on November 26, 2018. The 65-day outage extended beyond the schedule allocation of 37 days, with the overrun primarily attributable to direct impacts on resource availability related to Hurricane Florence and challenges with the complex transmission upgrade project.

Q. DOES THIS CONCLUDE YOUR PRE-FILED DIRECT TESTIMONY?

A. Yes, it does.

DUKE ENERGY PROGESS, LLC
SOUTH CAROLINA ANNUAL REVIEW OF BASE RATES FOR FUEL COSTS
NUCLEAR CAPACITY FACTOR PURSUANT TO S.C. CODE ANN. § 58-27-865(F)
REVIEW PERIOD OF MARCH 2018 THROUGH FEBRUARY 2019

1	Nuclear System Actual Net Generation During Review Period	27,802,924	MWH
2	Total Number of Hours during Review Period	8,760	
3	Nuclear System MDC during Review Period	3,548.33	MW
4	Reasonable Nuclear System Reductions	3,899,141	MWH
5	Nuclear System Capacity Factor = L1/((L2a*L3a)-L4)*100	102.28	%

DUKE ENERGY PROGESS, LLC
SOUTH CAROLINA ANNUAL REVIEW OF BASE RATES FOR FUEL COSTS
NUCLEAR OUTAGE DATA FOR REVIEW PERIOD OF
MARCH 2018 THROUGH FEBRUARY 2019

Nuclear outages lasting one week or more during the Review Period

Station/Unit	Date of Outage	Explanation of Outage
Brunswick 1	3/3/2018 - 4/4/2018	Scheduled Refueling - EOC 22
Harris 1	4/7/2018 - 5/10/2018	Scheduled Refueling - EOC 21
Robinson 2	6/14/2018 - 6/21/2018	Scheduled maintenance outage to replace turbine blades
Brunswick 1 [1]	9/13/2018 - 9/22/2018	Reactor shut down for Hurricane Florence
Robinson 2	9/22/2018 - 11/26/2018	Scheduled Refueling - EOC 31

[1] Brunswick 2 was also removed from service for Hurricane Florence, but only offline 6.3 days

DUKE ENERGY PROGESS, LLC
SOUTH CAROLINA ANNUAL REVIEW OF BASE RATES FOR FUEL COSTS
NUCLEAR OUTAGE SCHEDULE THROUGH BILLING PERIOD
MARCH 2019 THROUGH JUNE 2020

Scheduled nuclear outages lasting one week or more through the Billing Period

Station/Unit	Date of Outage[1]	Explanation of Outage

REDACTED

[1] This exhibit represents DEP's current plan, which is subject to change based on fluctuations in operational and maintenance requirements.